BELLCOMM, INC.

SUBJECT: Command Module Pressurization During Terminal Countdown - Case 330

DATE: April 26, 1966

FROM: L. G. Miller

ABSTRACT

During the third meeting of the Apollo Emergency Egress Working Group, a question was raised pertaining to the method of venting the command module on the launch pad if the crew was unable to do so. The time required to vent the spacecraft bears a direct relation to the time required to effect an emergency egress. This memorandum documents the history and present status of the matter and proposes a course of action for refining the time required to effect egress. Although not related to emergency egress, an unresolved question relating to cabin pressurization is also discussed.

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MEMORANDUM FOR FILE

INTRODUCTION

During the third meeting of the Apollo Emergency Egress Working Group,[1] a question was raised as to the method of venting the command module on the launch pad if the crew was unable to do so. If the pressure in the CM cabin is significantly greater than ambient (e.g., more than two or three inches of water), the inner hatch cannot be opened because of the pressure loading. An action item was placed on North American Aviation to determine what provisions exist for venting the cabin and what improvements could be suggested for speeding up the operation. The action item remained open during the fourth meeting of the working group as there was no one present from NAA to report. At the fifth working group meeting, however, an ASPO position on the matter was made known, and the action item was closed. This memorandum documents the history and present status of the question and proposes a course of action for refining the time required to effect egress. Although not related to emergency egress considerations, an unresolved question pertaining to cabin pressurization is also discussed.

HARDWARE CONFIGURATION

Only a limited portion of the command module hatch configuration is pertinent to this discussion. Specifically, the original question dealt with the inner or pressure hatch which is located on the side of the command module. This hatch seals, from the inside, against an O-ring arrangement which is located on the inner periphery of the opening in the CM pressure hull. A latching system forces the sealing surface of the hatch against the O-ring arrangement, thus sealing the cabin for pressurization. Due to this arrangement, any over-pressure in the cabin tends to increase the pressure against the O-ring.

The pressure hatch has an area on the order of 1200 square inches. Hence, a pressure differential of 5 psi corresponds to a force of some 6000 pounds. The hatch cannot be opened unless this force is reduced to some reasonable level, say about 100 pounds.

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[1] "Trip Report - Attendance at Apollo Emergency Egress Working Group Meeting, February 16, 1966," by L. G. Miller, Bellcomm Memorandum for File, dated March 3, 1966.

THE EGRESS PROBLEM

Having been asked to develop an egress plan for AS-202, the Emergency Egress Working Group sought a situation which would exercise the rescue system to the greatest possible degree. Although AS-202 is not a manned flight, it was felt that a demonstration of the effectiveness of emergency egress provisions under operational conditions could be staged and that such a demonstration was necessary in order to man-rate the egress plan. Considering the time required to effect a rescue, a situation whereby all three astronauts are incapacitated represented a worst case. It was decided to plan the demonstration on that basis.

As visualized, the rescue team would, upon orders, make its way to the umbilical tower, ascend the egress elevator, and cross the CM Access Arm which, by that time, would be locked in place. An NAA hatch technician would assist in removal of the boost protective cover and outer (ablative) hatch. If, however, the cabin pressure was significantly greater than ambient, the inner hatch could not be opened until the pressure was bled down to two or three inches of water (i.e., approximately a 100 pound force would then unseat the hatch).

Information then available indicated that the cabin would undergo a leak test following pressure hatch installation and that the cabin would be pressurized at lift-off. Normally, one of the astronauts would manually operate the cabin vent relief valve if the cabin had to be depressurized. Depressurization of an unmanned spacecraft, or one in which the astronauts or vent valves are not functioning, could take place from the outside through a bulkhead-type fitting in the pressure hatch. The fitting is furnished for the Module Leakage Test Unit, S14-079, the NAA ground support equipment used to perform the cabin leak check. The fitting is not accessible until the BPC is removed and the outer hatch is opened.[2]

The S14-079 was used at the launch pad during checkout activities associated with AS-201. When it was found that depressurization of the cabin was taking too much time, the unit was disconnected, and the cabin pressure was allowed to vent directly through the fitting in the pressure hatch. Even so, it took approximately ten minutes before audible evidence of venting ceased. This information does not constitute a valid basis for an appraisal of the situation. It does indicate, however, that a real problem could exist under certain circumstances. It is also possible that a somewhat lesser problem

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[2]We are not concerned here with activities prior to spacecraft close-out since this is not, by definition, within the scope of the Emergency Egress Working Group.

may even exist when the cabin vent relief valve is used. Again, valid data are not available, but the time required for depressurization would add directly to the time computed for performing an unaided egress. This, of course, might influence the decision of the Test Supervisor to initiate egress.

ASPO POSITION

A recent MSC internal letter from the Systems Engineering Division, PS, to the Flight Crew Division, CF, set forth the ASPO position on this matter. It stated that any series of events which might prevent CM venting from inside the cabin or lead to the disabling of all three astronauts on the pad was so remote that active consideration of the problem was not warranted. Even so, it was noted that some guidance was necessary as a precaution. The letter went on to state that the rescue team should use any means, to include physically damaging the spacecraft, to remove the astronauts if such a situation was to arise. This effectively closed the action item on NAA.

NAA RESPONSE

Shortly before the ASPO position was made known, R. F. Gately of NAA made a verbal response to the EEWG action item. He stated that NAA would request that the Ground Operations Requirements Plan be changed to require that the spacecraft be maintained at ambient pressure from the time of spacecraft close-out until lift-off. It is not clear at this time whether (1) this request will be pursued by NAA or (2) the solution is as simple as it appears to be.

At any rate, the NAA response did not include any on-pad depressurization times through either the cabin vent relief valve or the smaller fitting on the pressure hatch. It would seem that this information is desirable, if only to settle the question once and for all. The information might be obtained in conjunction with tests on AFRM 008 at MSC. As it stands, concrete numbers do not seem to be available.

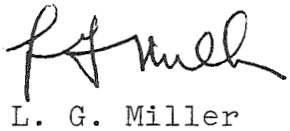
Although not related to emergency egress, the NAA proposal has given rise to a minor procedural question which deserves consideration. The CM cabin is purged with gaseous oxygen prior to close-out, and a 100% oxygen atmosphere is maintained during the mission. If the cabin is vented to ambient pressure, there might be some leakage of air or other gases back into the cabin. Of course, the problem could be alleviated by specifying that the cabin be maintained at a small positive pressure differential with respect to ambient. It is suggested that this be considered by MSC, assuming that any leakage would be undesirable.

SUMMARY

Although it is unlikely that all three astronauts could become disabled while awaiting lift-off, the possibility has been recognized and an approach has been provided for effecting an on-pad rescue.

The writer has been unable to determine the CM cabin pressure, following spacecraft close-out, with any certainty. Depending on this pressure, the time required to perform an unaided egress could differ significantly from the figures presently being used for planning purposes. It is suggested that experimental data on depressurization time be obtained over a range of possible cabin pressures in order to size the potential impact on egress. Of equal importance is the determination of the maximum CM over-pressure at which the inner hatch seal can be broken by the astronauts and/or the rescue team. As suggested in a recent memorandum,[3] it might also be of interest to assess the benefit of operating the post landing vents to reduce depressurization time. This test program might be accomplished in conjunction with AFRM 008 testing at MSC.

Finally, it is suggested that the CM cabin be vented upon conclusion of the cabin leak test. A small positive pressure differential should be maintained in the cabin, the maximum value being determined by the test program outlined above. A device capable of accurately measuring low pressure levels is required in the CM, and its presence should be verified.



2032-LGM-gmp L. G. Miller

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[3] "CSM Depressurization Considerations for Astronaut Pad Abort," Case 330, by T. A. Bottomley, Jr., Bellcomm Memorandum for File, dated 3/29/66.

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